

REMARKS

Claims 1-7 and 9-22 are pending in this application. Claims 9, 10, 12 and 19 stand rejected under 35 USC 112 as being indefinite. Claims 1-7 and 9-22 stand rejected under 35 USC 102(b) and 35 USC 102(e) as being anticipated by Beale, Hasz '189 or '141, Siemens, Toyota, Druchitz and United Technologies.

The applicant has cancelled claims 1-7 and 9-22 herein, thereby rendering the various rejections moot. New claims 23-31 have been added herein. The following comments are provided for the Examiner's consideration when reviewing these new claims.

The present inventors have recognized that the group of materials identified in the specification as spinel materials have properties that make them particularly well suited for use as a thermal barrier coating for protecting metallic materials exposed to a high temperature environment. The present inventors have particularly exploited the fact that the coefficients of thermal expansion of spinel materials closely match those of metallic substrates. The present inventors have found that the spinel materials may be used alone to provide an adequate degree of thermal insulation for the protection of metallic substrate materials in a high temperature gas turbine environment.

While it is true that spinel materials inherently exhibit the properties that the present inventors have found useful, it is also true that the prior art in this field has failed to teach or to suggest that a thermal barrier coating may be formed of a spinel material throughout its entire depth, as specified in the newly submitted claims. The prior art discloses uses of spinel materials as only a supplement to another material that provides the desired thermal insulation properties. Thus, claim 23 includes the limitation that "the thermal barrier coating comprising a spinel material throughout a full depth of the thermal barrier coating." The following is a brief discussion of each of the above-cited prior art documents to illustrate the novelty and non-obviousness of new claim 23.

Beele patent 6,127,048 describes the use of a spinel material as an anchoring layer 3 that is disposed between a bonding layer 4 and a thermal barrier coating layer 2. The thermal barrier coating layer 2 is described as a stabilized or partly stabilized zirconia,

thus teaching away from the present claim 23 limitation of the thermal barrier coating comprising a spinel material throughout its full depth.

Both of the Hasz patents 5,914,189 and 5,773,141 describe the use of a spinel material as a thin protective coating applied on the top surface of a thermal barrier coating layer. The spinel material provides a barrier against the infiltration of molten contaminant compositions. Here, again, because the spinel material is described as being only on a top surface of the thermal barrier coating, these patents actually teach away from the present invention.

Siemens WO 96/34128 describes the spinel material as an anchoring layer 3 deposited below a separate thermal barrier coating layer 2. This publication thus also teaches away from the present invention.

Toyota Japanese publication 63-274751 illustrates a spinel layer 4 disposed on top of a zirconia thermal barrier coating layer 3. The relatively thin spinel layer 4 functions in this application to provide protection against a corrosive atmosphere, whereas the thick zirconia layer 3 provides the thermal barrier protection. Again, this structure teaches away from the present invention.

Druschitz patent 5,037,070 describes a thin protective oxidized coating containing a layer of spinel and a layer of alumina formed over a nickel-based substrate material. The oxide coating is grown on the substrate material by exposing the substrate material to a high temperature. The oxide layer serves to protect the apparatus from molten iron and aluminum in a metal casting environment. This patent does not teach or suggest a thermal barrier coating material because it is not concerned with thermal protection, thus it does not anticipate the claim 23 limitation of a thermal barrier coating comprising a spinel material throughout its full depth.

Finally, the United Technologies European application 0 185 603 describes the use of a spinel material as one portion of a graded layer applied below a thermal barrier coating material. Figure 2 of this application illustrates the ZrO_2 abradable insulation layer with the separate graded layer (which may include spinel) disposed below, thus teaching away from the claim 23 limitation of a thermal barrier coating comprising a spinel material throughout its full depth.

In addition to the independent patentability of claim 23, the newly submitted dependent claims contain additional limitations that provide supplemental bases for patentability.

Claim 24 further limits the thermal barrier coating to consisting of the spinel material throughout the full depth of the coating. This limitation provides additional differentiation from prior art such as the United Technologies application 0 185 603 wherein the spinel material is combined with other materials.

Claim 25 includes the limitation that the thermal barrier coating material comprises an oxide material admixed to the spinel material. There is no teaching or suggestion in the prior art of such a combination.

Claim 26 includes the limitation that the spinel material is deposited directly on a surface of the metallic substrate. This is only possible because of the close match between the coefficients of thermal expansion of these two layers. The prior art teaches away from this limitation by requiring the use of a separate bond coat layer there between to limit the stresses created by the mismatch of thermal expansions created in prior art thermal barrier coatings that are not a spinel material throughout their full depth.

Claims 27 and 28 add limitations related to a roughness provided for providing a mechanical anchoring of the thermal barrier coating. Mechanical anchoring rather than chemical bonding is sufficient due to the limited level of thermal expansion stress created between these two layers.

Claim 29 includes the limitation of two portions of the thermal barrier coating comprising the spinel material in two different forms. The present inventors have recognized the benefit of the lack of significant physical-chemical property changes between the two forms of spinels, and this claim recognizes that certain embodiments may include both forms. Nothing in the prior art teaches or suggests such a limitation.

Claims 30 and 31 limit the spinel material to one of the disclosed materials that is of particular interest to the present inventors.

Reconsideration of the application in light of the above Remarks and allowance of presently added claims 23-31 is requested.

The undersigned attorney represents under 37 CFR 1.34 that he has been authorized to represent the assignee of the present invention. Correspondence should continue to be directed to the correspondence address of record. The Examiner is welcome, nonetheless, to call the undersigned attorney should additional clarification of this amendment be required or to otherwise expedite the allowance of the application.

Respectfully submitted,

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